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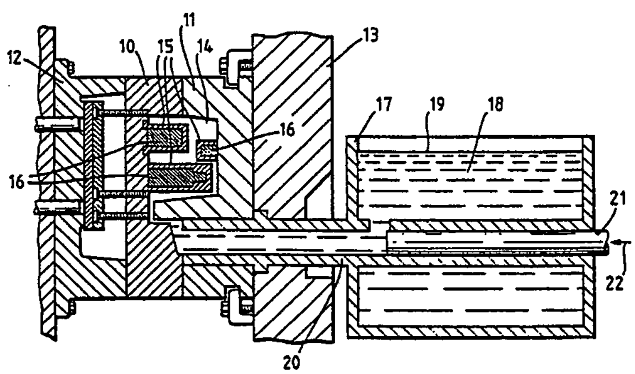
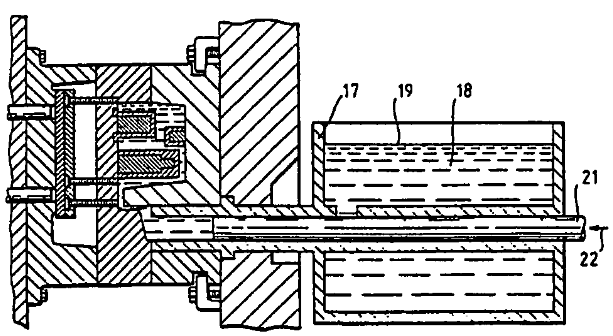
(54) Title: METHOD OF MANUFACTURING VALVE ETC. HOUSINGS





(57) Abstract

A valve block or like housing is formed by the steps of cold forging a cylinder (15) and inserting the cold-forged cylinder in a mould (10, 11), after which molten metal is injection moulded around the cylinder to form the valve block or housing with the cylinder forming a valve cylinder.

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DESCRIPTION

METHOD OF MANUFACUTURING VALVE ETC HOUSINGS

The present invention relates to the manufacture of valve housings, and particularly to the manufacture of valve housings which are formed within an alloy block, for example, multiple valve openings being located in a single block in order that fluid channels connecting the multiple valves can be connected without external fittings.

It is known to injection mould magnesium and similar alloys around cylindrical valve chambers which have been pre-formed by separate casting, reeming or drilling processes. Valve spools and the like, particularly those which are required to work axially, require the valve chamber to have a high degree of coaxiality and cylindricity whilst at the same time providing a surface macro-structure which has a high degree of smoothness. In order to produce such chambers by conventional methods, lengthy finishing processes are required such as honing or super-finishing. The manufacturing cost therefore of valve and like assemblies produced by such methods is extremely high. Furthermore, chambers formed by casting and then boring, reeming and finishing, result in a surface macro structure which has microscopic circular striations, resulting in undesirable tolerances between cylinder chamber and valve spool or piston.

Valve chambers in a block have been manufactured by the so-called "hot chamber" injection moulding process in which the material to be moulded is retained in a molten bath and is injected under pressure directly from the molten bath to the mould. Cylindrical chambers are formed by spigots in the mould around which the material is formed, but in

order to enable subsequent removal of the mould formers and spigots from the casting, it is necessary for the spigots to have a slight taper, in the order of 1°, so that chambers so formed require further finishing to achieve the desired degree of finish. Furthermore, working the surface of the cylindrical chamber cuts through the "casting skin" formed after the casting or moulding process and thus results in a chamber which, due to the microscopic porocity, of the casting, may not be absolutely fluid tight.

In order to overcome these problems and in accordance with the present invention therefore a valve or like housing is formed by the steps of cold forging a cylinder; and inserting the cold-forged cylinder in a mould and injection moulding around the cylinder to form a valve block or housing.

Preferably, the injection moulding process is a warm or hot chamber process as mentioned above, but it is envisaged that a cold chamber process, in which molten casting material is injected in a number of individual steps, may be used if desired. The advantage of the warm or hot chamber method is that it is considerably quicker and there are fewer inpurities incorporated in the moulding or casting as a result of the multiple injection steps, since, in the warm or hot chamber method, the injection apparatus itself lies under the surface of the moulten casting material.

A particular advantage of the method according to the invention, which is not achievable with other methods which involve casting around a pre-formed cylinder, is the negligible distortion of the cylinder and highly accurate location that can be achieved due to the high internal surface quality of the cylinder achieved by the cold forging step. A cold forged cylinder has a very high degree of

cylindricity and coaxiality and can thus be located on a locating spigot which is an extremely close sliding fit within the cylinder. This is just not possible with other methods where the cylinder is formed, for example, by a process which includes drilling, reeming etc. in which the surface finish is of lesser quality, resulting in less accurate fitting within the mould and the possibility therefore of distortion during the moulding process.

Additionally, a cold forged tube or cylinder has a surface macro-structure which extends in the axial direction to reduce friction and wear in a working valve spool or actuator sliding within the cylinder. Such cold forged cylinders have a considerably harder surface than that available with conventionally drilled and finished cylinders which increases the wear resistance of the surface. Furthermore, cold forged tubes or cups are not heated to the same degree during their initial manufacture and are therefore substantially free from internal stresses and tensions and thus relatively insensitve to temperature changes which, in other structures can lead to cracks and unsatisfactory finished products.

The speed of manufacture of blocks using the two stage process of the invention is considerably quicker than any producing comparable results that has hither to been achievable, resulting in cheaper manufacturing costs. At the same time, cold forging offers the possibility of greater repeatability, better functioning due to reduced friction in use, and higher tolerances, resulting in better quality finished products.

One example of a method according to the present invention will now be described with reference to the accompanying drawings, in which:-

Figures 1, 2 and 3 show similar stages of three different cold forging processes used to produce cylindrical articles, any one of which may be appropriate for use in the process of the invention, depending upon the required structure of the valves in the valve housing; and,

Figure 4 shows a warm or hot chamber moulding process at two separate stages, schematically in sectional form.

Figure 1 shows in parts a, b and c respectively, three separate stages during the cold forging of a cylinder which may be used to provide a valve cylinder for a spool valve in a valve assembly in accordance with the present invention. Cold-forging techniques are, in themselves, well known and therefore the method shown in Figure 1 will not be described in detail. However, it should be noted that the cylinder 1 which is formed during the cold forging part of the process has a very high degree of cylindricity and internal surface smoothness, the cylinder being formed by the extrusion of the material of the cylinder (for example stainless steel or aluminium) by impacting a mandrel 2 onto the surface of the material from which the cylinder is to be formed, the material being held in a matrix 3. As the mandrel impacts and works the material, the cylinder 5 is formed coaxial with and closely spaced around the mandrel 2.

Figures 2 and 3 show the formation of cylinders of different cross-sections in order to illustrate the variety of different shaped cylinders that may be produced by the drop-forging process, in turn to illustrate the wide range of valve spool cylinder forms which may be employed.

Turning now to Figure 4, Figure 4a shows a warm chamber injection moulding process prior to injection of molton material, in this case magnesium, into a

mould, to form a valve block or housing.

As shown, the mould comprises mould halves 10,11 mounted on platens 12,13 as is conventional. A cavity 4 formed between the mould halves contains three valve spool cylinders 15, each of which is supported on a cylindrical spigot 16 so as to be accurately and firmly held in position within the mould cavity.

Each of the spigots 16 lies with its axis substantially parallel to the direction of opening and closing of the mould halves in order to enable the finished moulded product to be removed from the mould cavity at the end of the moulding process.

Each of the cylinders 15 is formed by a cold forging process such as that of Figures 1, 2 or 3 and the supporting spigot 16 in each case is formed so as to be an extremely accurate and close fit within the related cylinder, so that when the molten magnesium is injected (as will be described later) there is reduced possibility of movement or distortion of the cylinder. It is due to the cold forging of each of the cylinders that close tolerances can be achieved. As is shown in Figures 4(a) and 4(b) (top cylinder) the lip of the cylinder can be widened so as to locate positively in the opposite mould half and thus further prevent any possibility of movement during moulding-in.

The mould includes a bath 17 of molten magnesium 18 which extends to the mould cavity 14 via a cylinder 20 into which an injection ram 21 is rapidly moved back and forth (in the direction of arrow 22) in order to force the magnesium into the mould cavity and around the cylinders 15. This step is shown completed in Figure 4(b).

During injection, high pressures (around 50 Bar) are present in the mould and the high degree of cylindricity of the cylinders 15, in turn allowing a

very close fit on the spigots 16, serves to avoid or reduce any distortion or movement of the cylinders, thus providing highly accurate valve cylinder bores in the finished product, without the time consuming, and thus expensive, prior methods.

An advantage of using the so called warm or hot chamber injection moulding process is that dross and magnesium oxides which are formed at the surface 19 of the bath of molten magnesium, are this kept from entering the flow of magnesium to the mould thus reducing impurities and improving the quality of the casting. However, it is possible to employ a cold chamber injection moulding process as described above, but this is not shown in the drawings for the sake of simplicity. Both magnesium and alluminium alloys may be injection moulded in a cold chamber process, but the warm or hot chamber process is only presently capable of being used with magnesium alloys. A further advantage of the hot chamber process is the increase in production velocity, to the extent that between one and two hundred strokes per hour may be achieved in comparison with less than one hundred for a cold chamber process.

An additional advantage is found to lie in the fact that in the axial direction of the macrostructure the cold forging process also provides a so-called "closed" profile as opposed to an "open" process which is achieved in machining processes such as turning or drilling, so that valve spools fitted in the valve cylinders can be more effectively sealed therein.

CLAIMS

1. A method of forming a valve block or like housing comprising the steps of:

(a) cold forging a cylinder;

(b) inserting the cold-forged cylinder into a mould; and

(c) injection moulding metal around the cylinder to form a valve block or housing.

2. A method according to claim 1, wherein the injection moulding step is a warm or hot chamber process.

3. A method according to claim 1, wherein the injection moulding step is a a cold chamber process, in which molten casting material is injected in a number of individual steps.

4. A method according to any of claims 1 to 3, wherein a plurality of cylinders are cold forged and inserted into a mould to form a plurality of valve chambers or like in a valve block.

5. A method according to any of claims 1 to 4, wherein the or each cylinder is supported in the mould on a spigot which is an accurate and close fit within the cylinder.

6. A valve block or like housing formed by the steps of cold forging a cylinder, inserting the cold-forged cylinder in a mould, and injection moulding around the cylinder to form a valve block or housing.

7. A valve block or like housing formed by the nethod of any of claims 1 to 5.

8. A valve block or like housing according to claim 6 or claim 7, wherein the cylinder is stainless steel or aluminium and the surrounding metal is a magnesium alloy.

Fig. 1.

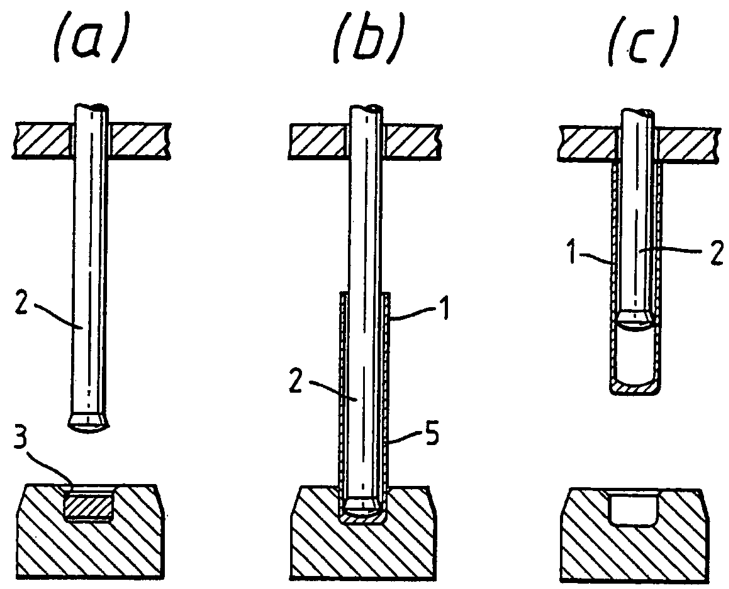


Fig. 2.

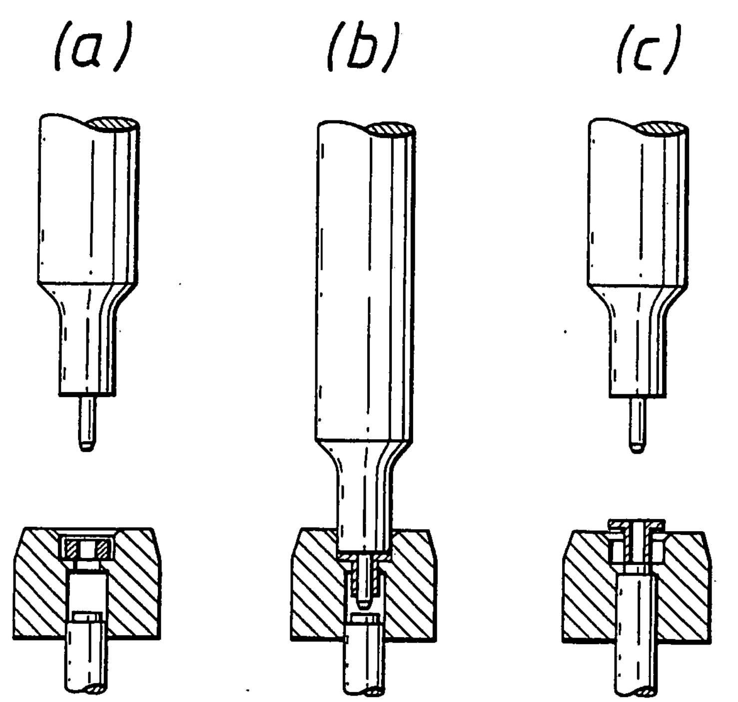


Fig.3.

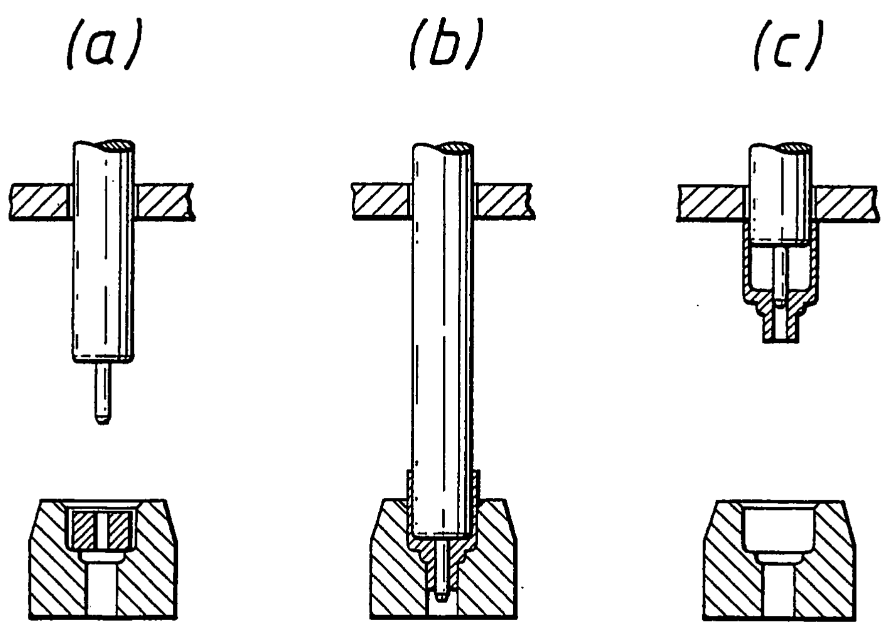
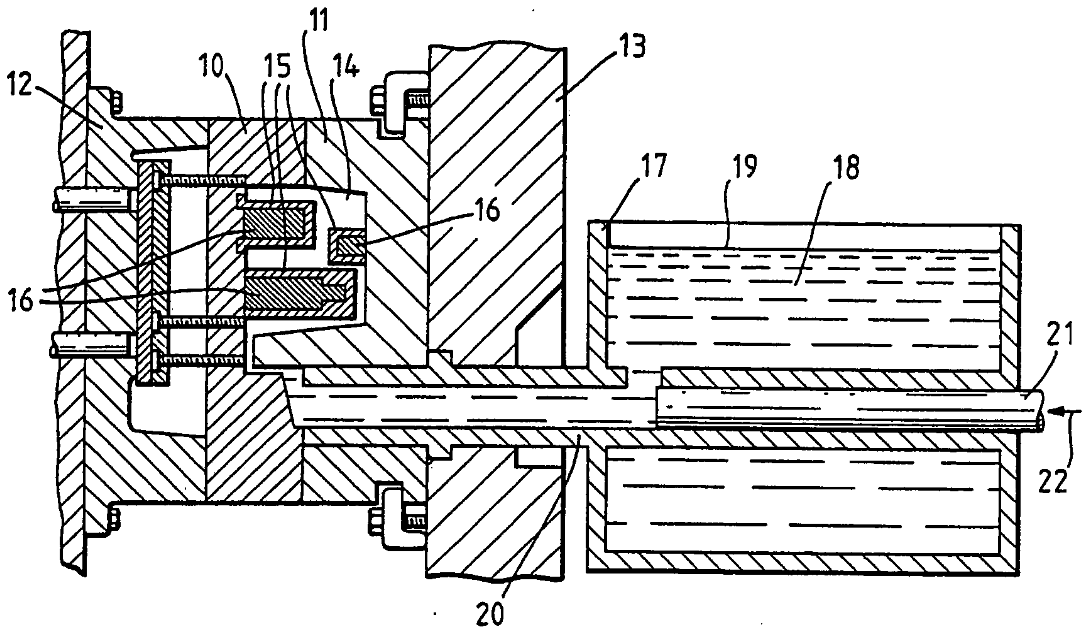
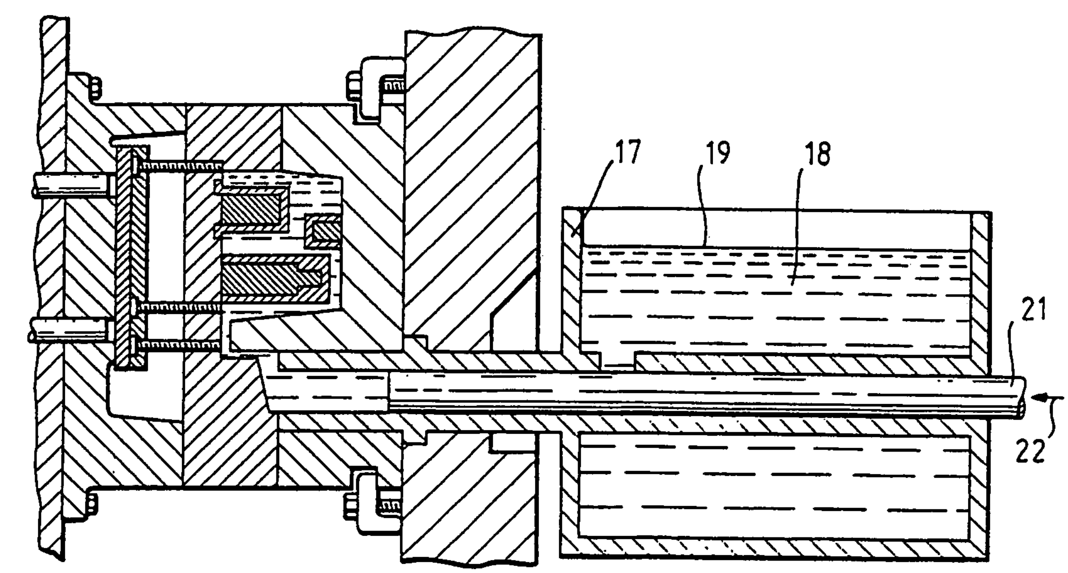


Fig. 4.

(a)



(b)



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 89/00956

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^5: B 23 P 15/00, B 22 D 19/00, F 16 K 27/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^5	B 23 P, B 22 D, F 16 K, B 60 T

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	Patent Abstracts of Japan, vol. 8, no. 210 (M-328)(1647), 26 September 1984 & JP, A, 59097752 (HONDA GIKEN KOGYO K.K.) 5 June 1984, see the abstract	1-3,6,7
Y		4,5
A		8
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Y	US, A, 3276082 (REYNOLDS) 4 October 1966, see figures	4,5
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	--	
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
4th December 1989	21 DEC 1989
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	T.K. WILLIS

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8900956

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US-A- 3276082		None	
US-A- 4516594	14-05-85	CA-A- 1236375	10-05-88
US-A- 4122596	31-10-78	None	

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